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(54) INJECTION MOLDING FIXED PIN GATE

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BACKGROUND OF THE INVENTION

This invention relates to an improved system for injection molding plastic, and more particularly to a new type of sprue gate utilizing an improved fixed pin.

In the past, dissatisfaction with the performance of sprue gated systems has lead to them being displaced to a considerable extent by valve gated systems, particularly for difficult to mold materials and applications. A major problem with sprue gating has been unacceptable stringing of the melt due to heat transfer characteristics in the gate area. Normally, a considerable portion of the heat is provided by the melt itself flowing into the area. However, this has the problem that melt flow is intermittent due to the alternating filling and ejection steps. Sufficient heat must be provided to maintain the melt in a molten condition adjacent the gate, while at the same time allowing the melt in the gate to solidify during ejection.

It is known to use a fixed central pin to contain the heating element. It extends concentrically in the hot runner passage leading to the gate and the melt flows around it. This has the disadvantage that the hot runner passage is restricted along a considerable portion of its length resulting in unacceptable pressure drop for most materials. Furthermore, there is a very high temperature drop across each relatively narrow portion of the runner passage from the heated central pin to the cooler outer portion. This requires excessively high temperatures at the central pin which may result in breakdown of the material.

As mentioned above, these problems have lead to the widespread use of valve gating systems, but these have the disadvantage of being much more costly.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to at least partially overcome the disadvantages of prior sprue gated systems by providing a system with a fixed pin projecting from the heater cast at an angle into the hot runner passage immediately upstream from the gate whereby heat is supplied to the runner passage by the heater cast from the outside, although additional heat may be transferred by the fixed pin from the heater cast to the gate area to maintain the melt in the gate area at a more uniform temperature.

To this end, in one of its aspects, the invention provides an injection molding system comprising a gate in a cavity plate leading to a cavity, a molding machine, a hot runner passage extending through a heated heater cast for conveying pressurized plastic melt from the molding machine to the gate, having the improvement wherein a heat conductive elongated fixed pin having a tip projects at an acute included angle from the heater cast into the hot runner passage towards the gate in a position wherein the tip is centrally located in the melt directly upstream from the gate, whereby the pressurized melt flows around the pin tip, through the gate and into the cavity and heat is conducted by the fixed pin from the heater cast to the melt in the gate area.

In another of its aspects, the invention provides an injection molding system comprising a gate in a cavity plate leading to a cavity, a molding machine, a hot runner passage extending through a heated heater cast for conveying pressurized plastic melt from the molding machine to the gate, the heater cast having a nozzle portion separated from the adjacent cavity plate by an air space, a hollow bore nozzle seal seated in the

nozzle portion of the heater cast and projecting therefrom substantially to the cavity plate, the nozzle seal having a funnel-shaped inner surface which defines the bore which leads from the hot runner passage in the heater cast to the gate in the cavity plate, the smaller end of the bore being in alignment with the gate, the improvement wherein a heat conductive fixed pin having a tip projects at an acute included angle from the heater cast into the hot runner passage towards the gate in a position wherein the tip extends into the nozzle seal directly upstream from the gate, the central axis of the fixed pin, nozzle seal and gate being in alignment whereby the pressurized melt flows around the pin tip, through the gate and into the cavity and heat is conducted by the fixed pin from the heater cast to the melt in the gate area, the tip of the pin having an outer surface in the shape of a truncated cone matching the inner surface of the nozzle seal to define a ring area therebetween through which the melt flows, the pin tip being axially located whereby the ratio of gate area to said ring area is from 2:1 to 1:2.

Further objects and advantages of the invention will appear from the following description, taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional view of a portion of a multi-cavity injection molding system according to a preferred embodiment of the invention; and

Figure 2 is an enlarged sectional view of a portion of the system seen in Figure 1.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is first made to Figure 1 which shows a

portion of a multi-cavity injection molding system showing one of the cavities 10 to which pressurized melt is conveyed through the hot runner passage 12 from the molding machine (not shown). A gate 14 in the cavity plate 16 leads to the cavity 10 and the hot runner passage 12 extends through a manifold 18 and a heater cast 20. It will be apparent that the hot runner passage 12 carrying melt from the molding machine branches in the manifold 18 to extend to other cavities (not shown) so that a number of products may be molded simultaneously.

The heater cast 20 is heated by an electrical element 22 which is cast into it. The heater cast 20 is mounted in the cavity plate 16 on insulation bushing 24 and has a nozzle portion 26 which is separated from the cooled cavity plate 16 by air space 28 to reduce heat loss from the heater cast. The heater cast 20 is normally formed of beryllium copper which has a high thermal conductivity to provide a more even heat distribution throughout. The hot runner passage 12 extends through a bushing seal 30 which is seated in the heater cast 20 to reduce leakage problems where the manifold 18 abuts on the heater cast 20.

As best seen in Figure 2, a nozzle seal 32 having a hollow bore 34 formed by a funnel-shaped inner surface 36 is seated in the nozzle portion 26 of the heater cast 20 and extends across the air gap 28 to abut on the cavity plate 16 around the gate 14. While providing some additional heat flow to the melt in the gate area, the nozzle seal 32 is normally formed of titanium which has a low thermal conductivity to avoid excessive heat transfer to the cavity plate 16. The nozzle seal 32 also serves to prevent the escape of pressurized melt into air space 28.

The central axis of the nozzle seal 32 is in alignment

with the central axis of the gate 14 and the bore 34 of the nozzle seal 32 extends from the hot runner passage 12 to the gate 14 without any sharp corners or dead spots being formed. A fixed pin 40 is mounted in the heater cast 20 to project into the hot runner heater 12 upstream from the gate and it has a bullet-shaped tip 42 which extends into the nozzle seal 32. The hot runner passage 12 extends through the heater cast 20 at an angle to allow the fixed pin 40 to be centrally located with its longitudinal axis also in alignment with the central axis of the nozzle seal 32 and gate 14. In this embodiment, the angle is about 15°, although it may vary depending upon the configuration of the heater cast 20. In this position, the pressurized melt flows around the tip 42 of the fixed pin 40, through the gate 14 and into the cavity 10 with a minimum of lateral displacement of the tip from its central position. Although the pin 40 does not move during use, it is mounted to be axially adjustable to vary the position of the tip 42 in the nozzle seal 32 depending upon the type of material being molded and the application. Axial adjustment is carried out by removing set screw 43, adding or removing washers 44 under shoulder portion 45, and then replacing the set screw. The fixed pin 40 has a high thermal conductivity and in this embodiment is formed of cast steel, although it may also be formed of beryllium copper or even at least a portion of it of a "heat pipe" to improve the thermal conductivity. Although it is normally solid, it may have a thin central channel to receive a thermocouple extending down near the tip. The outer surface 46 of the tip 42 of the fixed pin 40 has the shape of a truncated cone, although it may be rounded or even pointed in other embodiments. The minimum cross sectional area through which the melt flows between the inner surface 36 of the nozzle

seal and the outer surface 46 of the pin tip 42 is defined as the ring area. It has been found that desirable flow characteristics are provided when the pin is sized and axially located close enough to the gate to maintain the ratio of gate area to ring area from 2:1 to 1:2.

In use, molding commences after the system has been assembled as described above, the manifold 18 and heater cast 20 heated, and the cavity plate 16 cooled (by means not shown), the pressurized melt from the molding machine flows through the hot runner passage 12, around the portion of the fixed pin 40 projecting into the hot runner passage 12, past the pin tip 42, through the gate 14 and into the cavity 10. When the cavity is filled, the pressure is relieved, the gate freezes over and the mold is opened to eject the molded product. The mold is then closed, melt pressure applied to drive the sprue from the gate into the cavity and the process is repeated. Additional heat from the heater cast 20 flows along the fixed pin 40 to its tip 42 to maintain the melt in the gate area at a more uniform temperature. This prevents too much of the melt from solidifying when the gate is frozen during ejection, thus reducing stringing of the melt.

Although the disclosure describes and illustrates a preferred embodiment of the invention, it is to be understood that the invention is not restricted to this particular embodiment. In particular, it will be apparent that a fixed pin may be used without a nozzle seal if the advantages provided by a nozzle seal are not required.

The embodiments of the invention is which an exclusive property or privilege is claimed are defined as follows:

1. In an injection molding system comprising a gate in a cavity plate leading to a cavity, a molding machine, a hot runner passage extending through a heated heater cast for conveying pressurized plastic melt from the molding machine to the gate, the improvement wherein a heat conductive elongated fixed pin having a tip projects at an acute included angle from the heater cast into the hot runner passage towards the gate in a position wherein the tip is centrally located in the melt directly upstream from the gate, whereby the pressurized melt flows around the pin tip, through the gate and into the cavity and heat is conducted by the fixed pin from the heater cast to the melt in the gate area.

2. A system as claimed in claim 1 wherein the central axis of the fixed pin is in alignment with the central axis of the gate.

3. A system as claimed in claim 1 wherein the tip of the fixed pin is bullet shaped.

4. A system as claimed in claim 1 wherein the ratio of gate area to the minimum ring area through which the melt has to flow around the pin is from 2:1 to 1:2.

5. A system as claimed in claim 1 wherein the position of the fixed pin is longitudinally adjustable.

6. A system as claimed in claim 1 wherein the fixed pin is formed of steel or beryllium copper.

7. A system as claimed in claim 1 wherein at least a portion of the fixed pin is formed of a heat pipe.

8. In an injection molding system comprising a gate in a cavity plate leading to a cavity, a molding machine, a hot runner passage extending through a heated heater cast for conveying pressurized plastic melt from the molding machine to the gate, the heater cast having a nozzle portion separated from the adjacent cavity plate by an air space, a hollow bore nozzle seal seated in the nozzle portion of the heater cast and projecting therefrom substantially to the cavity plate, the nozzle seal having a funnel-shaped inner surface which defines the bore which leads from the hot runner passage in the heater cast to the gate in the cavity plate, the smaller end of the bore being in alignment with the gate, the improvement wherein a heat conductive fixed pin having a tip projects at an acute included angle from the heater cast into the hot runner passage towards the gate in a position wherein the tip extends into the nozzle seal directly upstream from the gate, the central axis of the fixed pin, nozzle seal and gate being in alignment whereby the pressurized melt flows around the pin tip, through the gate and into the cavity and heat is conducted by the fixed pin from the heater cast to the melt in the gate area, the tip of the pin having an outer surface in the shape of a truncated cone matching the inner surface of the nozzle seal to define a ring area therebetween through which the melt flows, the pin tip being axially located whereby the ratio of gate area to said ring area is from 2:1 to 1:2

ABSTRACT OF THE DISCLOSURE

This invention relates to a system for injection molding plastic using a novel type of sprue gating having a fixed pin. A heater cast with a lower nozzle portion is spaced from a cavity plate by an insulating air space and a hollow nozzle seal extends across the air gap between the nozzle portion of the heater cast and the cavity plate around the gate. The hot runner passage from the manifold extends through the heater cast at an angle into the hollow nozzle seal. The heat conductive fixed pin is centrally located in the heater cast in alignment with the nozzle seal and gate and projects at an acute included angle from the heater cast into the hot runner passage immediately upstream from the gate in a position in which the tip extends towards the gate into the nozzle seal. The size of pin tip and the axial position of the pin are selected so that the ratio of gate area to the minimum ring area between the inner surface of the nozzle seal and the outer surface of the pin tip through which the melt must flow is from 2:1 to 1:2. Although the primary source of heat to the runner passage is from the heater cast on the outside, some heat does flow along the fixed pin from the heater cast to the tip to provide an additional source of heat in the gate area to maintain the melt at a more uniform temperature to reduce stringing of the melt.

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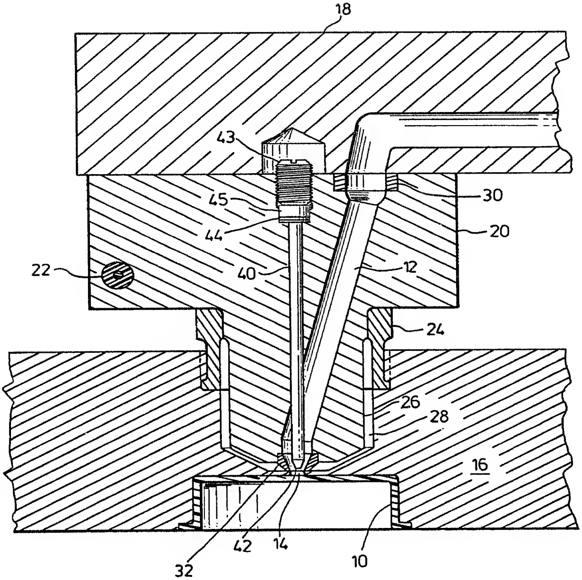

FIG.1.

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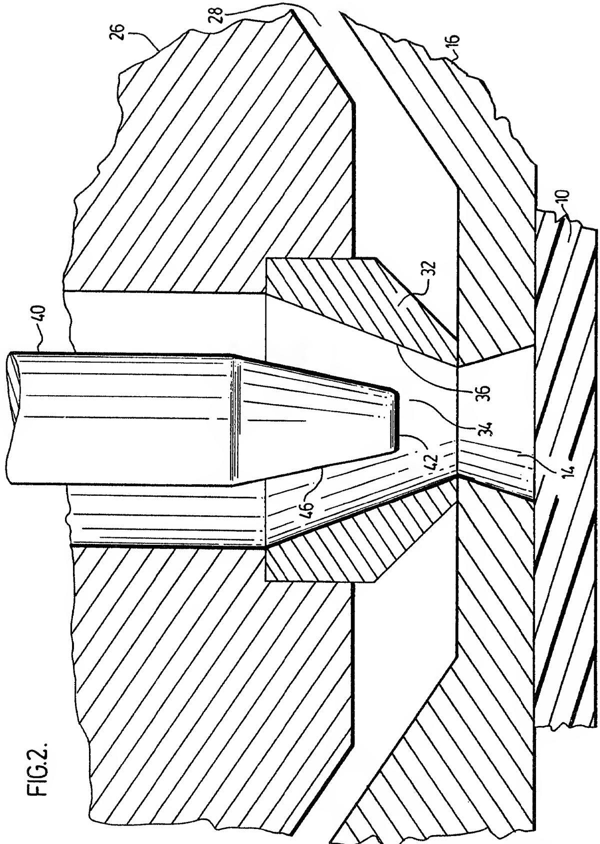

FIG.2.

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